# MORPHOLOGICAL APPROACH FOR TEMPLATE MATCHING

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# INTRODUCTION

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Template–matching (area based approach)

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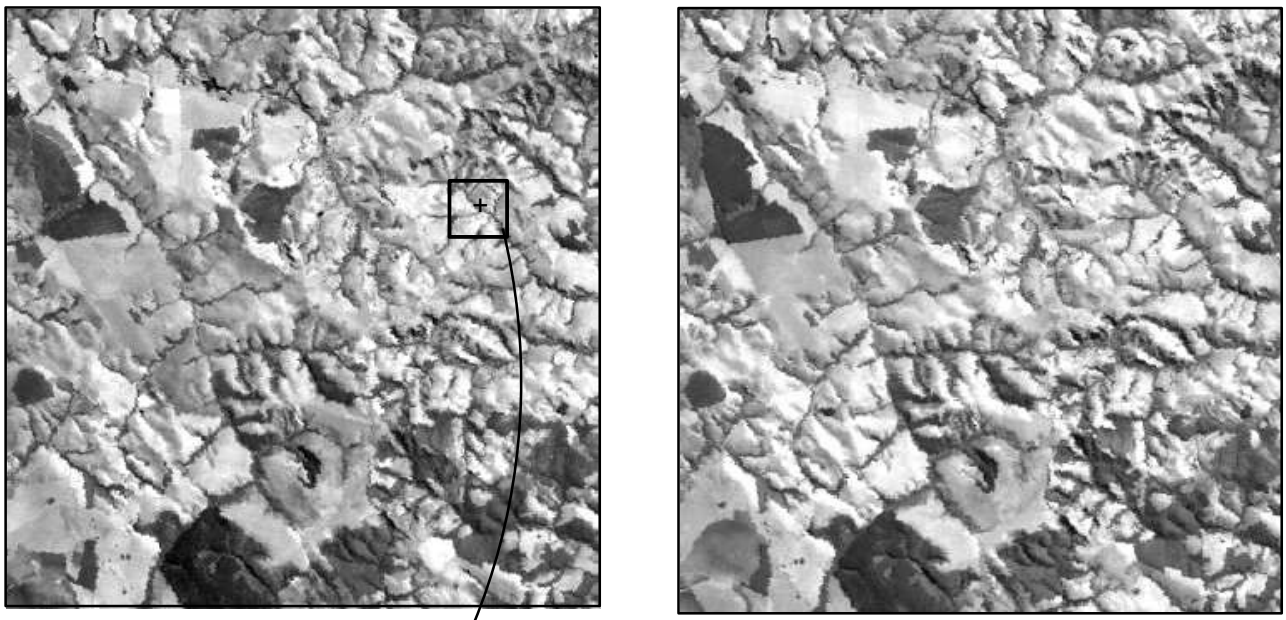
Finding out in a *search image* the *location* of a *template*.



Template

Search image

# INTRODUCTION

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## VECTOR SPACE APPROACH

Euclidian norm $\Rightarrow$ Sum of products (correlation)

$l_1$ norm $\Rightarrow$ Sum of minima (morphological correlation)
(Maragos 1988)

## NONLINEAR APPROACH

Template extraction characterization $\Rightarrow$ Inf separable operator
(Ronse 1996)

Sum of a gray–scale erosion and gray–scale anti–dilation
(Khosravi & Schafer 1996)

# TEMPLATE MATCHING ALGORITHM

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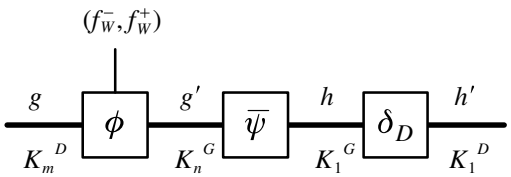


$$\text{Let } K_m = [0,m] \quad \text{and} \quad n = \#W$$

$$f_W^-(x) \triangleq \max\{0,\ \min\{m,\ f_W(x) + c_1\}\}$$
$$f_W^+(x) \triangleq \max\{0,\ \min\{m,\ f_W(x) + c_2\}\}$$

$$\phi \triangleq \sum_{i \in \mathbf{n}} \lambda^i \quad \text{where} \quad \lambda^i \triangleq \varepsilon^i_{f_W^-(w_i)} \wedge \delta^{ai}_{f_W^+(w_i)}$$

$$\varepsilon_l{}^i(g)(x) \triangleq \begin{cases} 1 & \text{if } g(x + w_i) \geq l \\ 0 & \text{otherwise} \end{cases} \quad \text{and} \quad \delta_l{}^{ai}(g)(x) \triangleq \begin{cases} 1 & \text{if } g(x + w_i) \leq l \\ 0 & \text{otherwise} \end{cases}$$

Equivalently,

$$\phi(g)(x) = \#\{i \in \mathbf{n} : g(x + w_i) \in [f_W^-(w_i), f_W^+(w_i)]\}$$

# TEMPLATE MATCHING ALGORITHM

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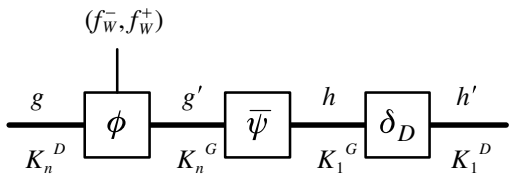


$$\overline{\psi} \triangleq \bigvee_{l=0,\ldots,n} \lambda_l \quad \text{where } \lambda_l \triangleq \varepsilon_l \wedge \delta^{\mathrm{a}}{}_l$$

$$\delta_l(f)(x) \triangleq \begin{cases} 1 & \text{if } f(x) > l \\ 0 & \text{otherwise} \end{cases} \quad \text{and} \quad \varepsilon_l(f)(x) \triangleq \begin{cases} 1 & \text{if } f(x) \geq l \\ 0 & \text{otherwise} \end{cases}$$

$$\delta^{\mathrm{a}}{}_l \triangleq \delta_G{}^{\mathrm{a}} \circ \delta_l$$

$$\delta_G{}^{\mathrm{a}}(f) \triangleq \begin{cases} 1_G & \text{if } f = 0_G \\ 0_G & \text{otherwise} \end{cases}$$

Equivalently,

$$\overline{\psi}(g')(x) = \begin{cases} 1 & \text{if } g'(y) \leq g'(x) \quad (y \in G) \\ 0 & \text{otherwise} \end{cases}$$

# NUMERICAL EXAMPLE

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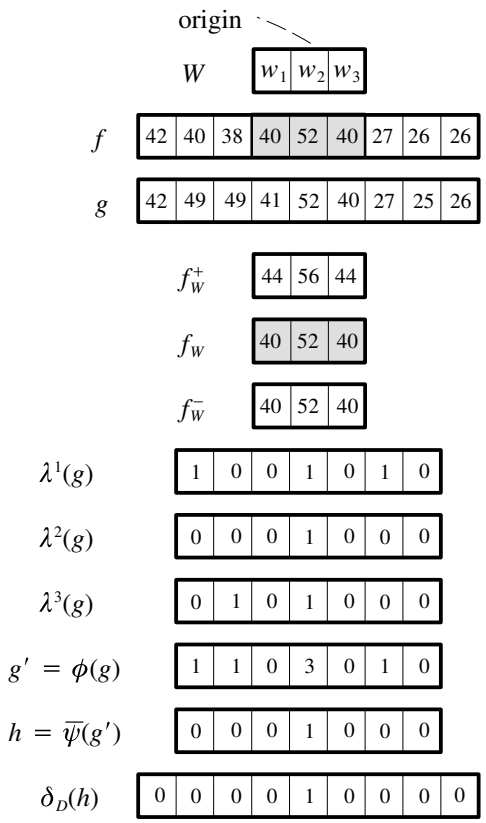

# EXPERIMENTAL RESULT

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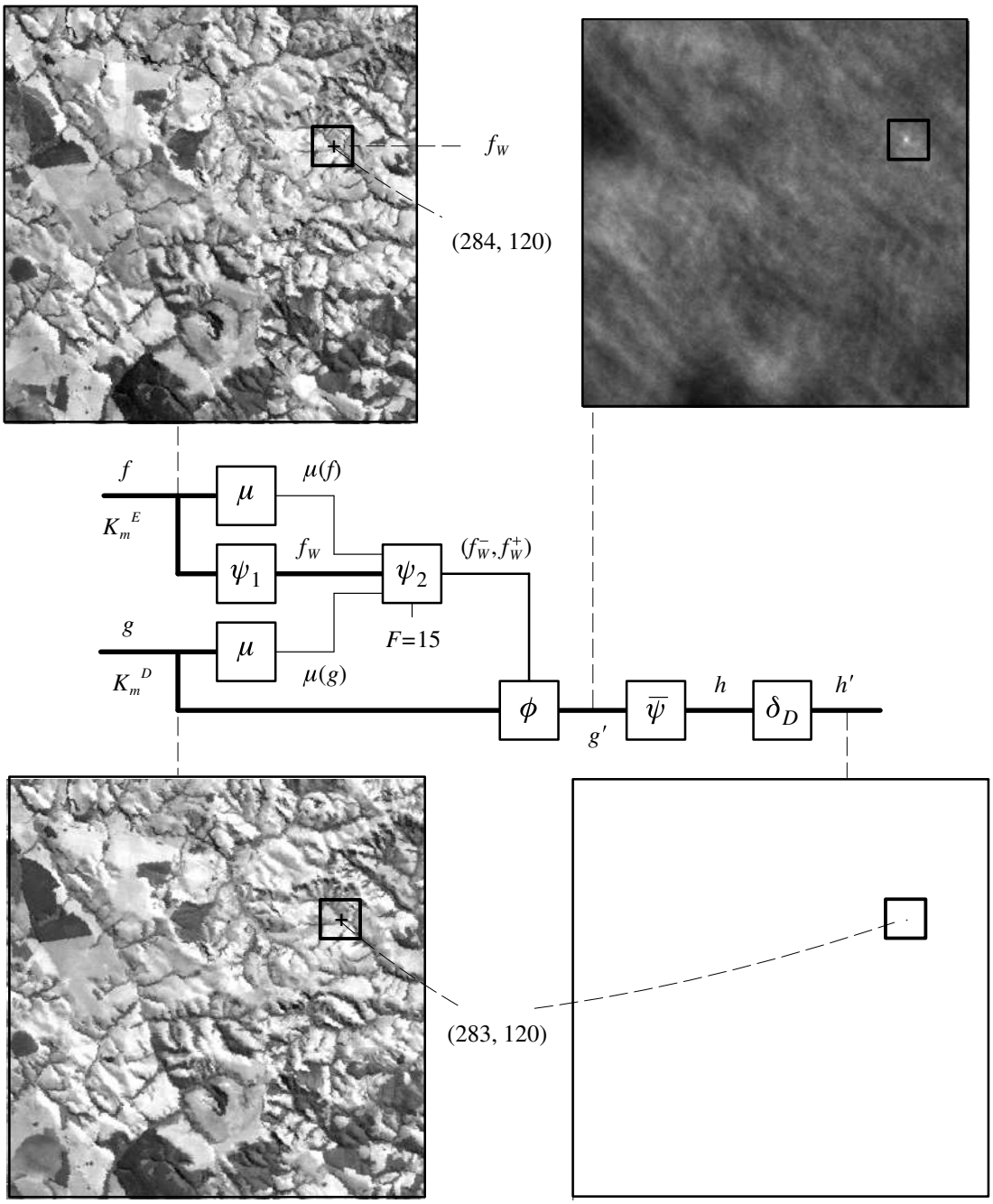
## TM/LANDSAT image



# EXPERIMENTAL RESULT

(2/2)

$$n = 51 \times 51 = 2601$$

| Parameters of the Experiment | | Result of the Algorithm | | Visual Location |
|---|---|---|---|---|
| Template Center in the Reference Image $f$ (col., row) | $F$ | Maximum value in $g'(G)$ | Position of the Maximum Value (col., row) | Template Location in the Search Image $g$ (col., row) |
| (241,37) | 15 | 580 | (240,37) | (240,37) |
| | 30 | 1151 | (240,37) | |
| | 45 | 1528 | (240,37) | |
| (284,120) | 15 | 571 | (283,120) | (283,120) |
| | 30 | 1057 | (283,120) | |
| | 45 | 1440 | (283,120) | |
| (37,243) | 15 | 657 | (37,243) | (37,242) |
| | 30 | 1250 | (36,242) | |
| | 45 | 1648 | (36,242) | |

# REFERENCES

(1/1)

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Morphological decomposition of extreme gray–level location operators.
In: Brazilian Workshop 97 on Mathematical Morphology, 1997, São José dos Campos, *Proceedings*,
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